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Educational games present the complex realities of simultaneous interactive processes more accurately and effectively than serial processes such as lecturing and reading. Objectives of educational gaming are to motivate students by presenting relevant and realistic problems and to induce more efficient and active understanding of information. Games are efficient learning devices because they allow three levels of learning to occur simultaneously without ability grouping of students. These levels are (1) efficient learning of facts, (2) learning of cause and effect relationships by substituting gaming for personal experience, and (3) learning of strategic thinking concepts by considering results of alternative courses of action. Games focus on reality but are combinations of skill, chance, reality, and fantasy. In designing games one must (1) define overall objectives and scope; (2) identify the key actors, their objectives, and constraints; (3) determine an interaction sequence and decision rules; (4) identify the win criteria; and (5) choose the form of presentation. Compromises must be made between simplification and realism, concentration and comprehensiveness, and melodrama and analysis. The attempt to include too much in one game must be avoided. (TT)

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GAMES AND SIMULATION

Dr. Clark C. Abt

Educational games are nothing very new. Studies of primitive tribes indicate that most children in primitive societies learn by mimetic games. This isn't completely foreign to our own culture. Small children play house, they try out adult roles all the way through adolescence. This experimentation with adult roles is pleasurable to them because it gives them a chance to imitate their parents and to try out something exciting. It also teaches them something about the problems involved.

The use of games in a formal educational sense is also not new, except perhaps in the schools. Our games development has its roots in military planning and war gaming, which was initiated early in the nineteenth century by the German general staff. War gaming was a way of experimenting in a laboratory setting with large-scale interaction problems that were too expensive or impractical to try out in full scale. The educational games method is a laboratory method analogous to the physics lab and the chemistry lab. It has perhaps its most immediate application in the areas of social sciences and humanities, where there is very little opportunity conventionally for the student to participate actively in decision-making concerning the problems that are under study.

In the war-gaming kind of activity the objective is to solve problems and to train or educate the staff in the solution of those problems.

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In educational gaming we have another objective, the one that is usually stressed in superficial articles about educational games as being the principal advantage, and that is the motivational objective. Educational games do motivate, and they motivate student populations that have particular difficulty with conventional school process, in a particularly effective way. However, I suspect that most of you administer school populations that are already quite highly motivated and so you have problems other than motivation. You have problems of instruction efficiency as well. It is my belief that educational games can communicate more facts and ideas per unit time, and I will give you some of the reasons for this a little later.

For complex interactive processes where many things are happening simultaneously in time, it's very difficult to understand such a process unless one is immersed in it. Try describing a football game in prose. There are too many things happening at once. The same is true of an election campaign, or a diplomatic crisis, or the interaction of inflationary and deflationary forces in an economy. When so many forces are interacting at once, any prose description, any verbal description either verbal or printed, necessarily requires a high level of abstract thinking. One must keep in mind, while A was happening, B was happening, while A and B were happening, C was happening, and three of these things interact with a fourth factor, etc. One can flow-chart these parallel processes, or one can simulate them, but it is very difficult to understand them just by hearing about them or reading about them in spoken language which is necessarily a serial process. So for all of these complex interactive processes, which we study particularly in the social studies and in the social sciences, a simulation approach is a way of presenting the realities of simultaneous interaction more accurately and effectively than any verbal description can.

Before I go into the application of games, let me describe to you what they're like. "Bushman Hunting" and "Seal Hunting" were elementary social studies games developed for ESI that simulate some of the social organization of African bushmen and Eskimos, and show how they must organize themselves in order to maximize their chances of gaining food. It shows the relationship between technology and social organization and environment in these two primitive cultures, for fifth and sixth grade social studies.

"Empire," which some of you may have seen on the 21st century Walter Kronkite program a couple of months ago, is a game for junior high school history students that simulates the mercantile conflict between England and the American colonies just before the American Revolution. In this game the students take the roles of New England merchants, London merchants, Southern planters, Colonial farmers, West Indies planters, European merchants, and the Royal Navy; and they exchange the commodities of the period--rum, molasses, rice, cotton goods, timber, fish, etc. which are produced by the various colony teams and consumed by the various teams. This was quite accurately researched, and some thirty commodities are exchanged for historically fairly accurate prices at historically fairly accurate rates simulating the mercantile economy of the period. The Navigation Acts are more and more strongly enforced by the British Navy arousing the colonists' ire and forcing them to conspire for increased smuggling activities. This gradually leads to a great sense of alienation between the players that play the American colonies, and the players that play the London merchants.

Part of the reason for the development of this game was that the seventh graders were having difficulty understanding what the American Colonists were so angry about as the British began to enforce the Navigation Acts more stringently. This gives them a real feeling for why there was a sense of outrage and frustration. Also, a great many facts are conveyed about the actual economics of the period which are realistically simulated: the interaction of the British foreign and economic policies, and the business operations of colonists.

"Adventuring" is a game that is part of a unit on the English Civil War that we've developed on the theory that the English Civil War raises most of the constitutional issues presented in the American Revolution, only a hundred years earlier and in somewhat different form. In "Adventuring" we simulate the entire socio-economic structure of Caroline England by representing the three politically active classes--the yeoman, the merchant, and the gentry--operating on the three sides of a socio-economic pyramid which players try to climb to the top where the royal court is. The players get a chance to choose alternative careers, politics, and mates; and depending on what careers they choose, which are, of course, constrained by their initial social and economic status,

their family fortunes advance or decline. This is to give them an introduction to the overall social structure of the period and to make it clear that the socio-economic ladder is steep but could be readily climbed. It was also slippery. There is a saying, "From shirt sleeves to shirt sleeves in three generations." This is a difficult concept to get across in junior high school, and not only in junior high school, because steep social ladders tend to be associated with social structures where there's not much upward or downward mobility, and this wasn't the case in Caroline England.

In the "Revolution" game, a role-play in five acts, we relate the gradual progression of the round-heads, the Puritans, towards Revolution in Caroline England, and they go through successive stages of their rights being outraged and the denial of legal redress. There's a conspiracy in Parliament, and the attempted arrest of the five members is dramatized. I want to point out a little incident here that I think is significant, particularly in historical education games. It's quite possible that the game comes out quite differently than from what happened in history, and that is often desirable because the three important parts of game learning occur in the design and preparation for the game, the play of the game, and the discussion afterwards in which the game outcome is compared to reality.

In the "Revolution" game which we had in one junior high school, Queen Henrietta-Maria was attempting to influence King Charles to enter Parliament illegally and arrest the conspirators against him. In fact he did make this attempt to arrest the five members, and this is one of the things that precipitated Parliamentary opinion against him and initiated the Civil War. But in our particular trial play, the little boy who was playing King Charles, when continually badgered by the little girl who was playing Queen Henrietta-Maria, finally turned around to her and told her to shut up and did not go into Parliament. This unpredicted response led to a very useful discussion at the conclusion of the game of the influence of interpersonal relations among key decision makers on the outcome of these games in actual history.

In another case we played a game called "Grand Strategy" which simulated international relations during the World War I period--in a Job Corps Camp. It was terminated by the successful coalition of the United States and Germany, which was something of a surprise. It was due mainly to the firm firendship that existed between the players

who played the Kaiser and Wilson. This, too, was a subject of lively discussion afterwards. So it isn't necessary that the outcome simulate reality, only that the forces involved and the interaction simulate reality.

"Steam" is a game that is played in a shoebox, or something that looks like a shoebox, which shows the impact of technological innovation and economic change in the Industrial Revolution. The shoebox is filled with domino-like layers of wood and coal, and as you go down through the coal, water seeps in through an adjacent river, and you have to buy the rights to use various qualities of steam engine. The players who play the innovators sell patents to more and more advanced steam engines which are required to pump out the water and sell the coal, etc.

"Manchester" is an economic history game. This is a complete little economic microcosm. A board represents the ownership pattern in a village in rural England around 1800. The villagers move from the village to the city of Manchester because they are attracted by higher wages. In the town there are mill owners which have a demand function which fluctuates without their knowledge, and in the village the enclosure of land gradually drives the land holders to seek higher wages. If they're thrown out of work in town because the mill overproduced cotton goods and they can't sell their goods (which actually occurred during the Napoleonic conflict in the early 19th century), then the workers are unemployed, have to go to a work house, and eventually wind up back in the village.

The games themselves are of two basic types and combinations in between. They may be board games (and I suppose "Monopoly" is a familiar example of a board game although I don't think it's a good educational game because the outcomes of the moves are relatively independent of the quality of the decisions by the players). The other type of game is a role play game, which is a little like a partially structured drama whose ending is still uncertain.

Educational games in general are combinations of systems analysis and dramatics. The systems analysis is in the design of the game and the analysis and restatement of the problem in a structured analytical format, and the dramatics comes in in selecting those aspects of the situation which are full of conflict and uncertainty and hence whose outcomes are unknown and lend dramatic interest to the activity. The essence

of drama is a conflict of forces whose outcomes are unknown and in which the forces are of significance to the people observing. Any good play has uncertainty about how it will come out because of conflict between principal characters; the requirement is that one care about the characters--they can't be utterly trivial people. We must construct our educational games in such a way that all the roles have some fantasy interest for the players and the interaction between these roles has an uncertain outcome.

There are three kinds of learning that go on in educational games. On the most elementary level there is the learning of the facts of the situation. I think an educational game can get across a greater density of facts per unit time than alternative techniques. The main reason for this is that multiple parallel processes are going on in a games classroom. For example, in the "Empire" game that I described briefly before, the seven teams have quite different economic and political problems. The New England merchants are really directly competing with the London merchants. They are selling manufactured goods and buying raw materials and they are major shippers, and so they are learning about this direct competition. The Southern planters, on the other hand, are in the position of requiring an enormous amount of credit from the London merchants; and the London merchants, being in a strong creditor position, have enormous power over the whole price structure of the economy and also the social structure in the Southern plantations. This is quite a different problem. The point is, all the students in the classroom that are divided into these small group teams are learning different things, at the same time, and in interacting they learn from each other about these different things.

If you can assume in a classroom that learning is inversely proportional to teaching, or that the more the students learn the less there is of the solitary teaching activity by the teacher, then the greater the student participation, the more the actual learning that goes on. In an educational game, all students are actively learning something. They subsequently learn from each other what they didn't learn by themselves. Perhaps not 100%, perhaps not even 60%, but there is some transfer from student to student, so each student is fully engaged during the classroom period, and subsequently, and in discussion with his peers, also learns things that he didn't himself learn but that perhaps his peers learned.

There's a much greater intensity of interaction with the factual content.

The second level of learning in educational games is of the cause and effect relationships, the processes in any complex interactive situation. In this respect the games are relatively unique in being able to present a complex interaction simulating the problem that isn't really well done in either written or spoken material. The reason we as adults can understand the complex interaction processes described in written and spoken form is because we can base our understanding on analogies to direct personal experience. We, in a sense, simulate the process we're studying, in our heads, by referring to past experience. To an elementary or a high school student who doesn't have that much experience to analogize with, the abstractions when presented the first time without any concrete simulation of their interaction remain abstractions.

The third level of learning in educational games is that of the comparison of alternate costs and benefits, risks, and opportunities following different courses of action. This is strategic thinking, or long-range planning. The interesting thing about educational games learning is that these three levels of education can go on simultaneously, not only in individuals but different students in different levels of competence can learn in the same game. For example, in one educational game played in the South End Community Center in Boston, the little girls played ranged from an 11 year old illiterate to a 16 year old girl who was about to be admitted to college. There was a tremendous range not only in reading level achievement, but in all levels of achievement, and they were all interacting in the same educational game. The little girl who was practically illiterate learned that there was such a thing as interest on loans, while the girl who was going on to college learned some of the strategic thinking in comparing alternative strategies, and she had the facts and the process relationships down very quickly. So, these three levels of learning can go on at once, and there is no need, as far as we can see, to structure classes by different ability gradings for the use of educational games.

We do believe, however, that it is wise to have a combination of achievement levels in each team in a game. Most of the games involve small group teams competing with each other. Ideally, each team has a fast track and, perhaps, a slow track and a middle track student on it.

There are usually three players on each team to even up the competition. It is sometimes stated that educational games spur competitiveness in the classroom, but actually when you compare the ratio of competitiveness to cooperation in educational games to pure parallel process conventional learning in the classroom, there is greater relative cooperation because the team members must work together. Although the teams compete with each other, within teams there has to be cooperation.

Now, I would like to quickly run through the basic elements of games, and then give you a brief overview of how these games are designed. I believe that the way the classroom teacher can get the most out of educational games is to design his own games, and, furthermore, to have his classes design games. You can have your students do most of the hard work in designing the games; this work in itself is a worthwhile educational experience.

Games are all mixtures of skill, chance, reality, and fantasy. Examples of games of skill are games such as chess where there are very few chance interactions, and knowledge of the situation directly determines the outcome. A game of chance is a dice game, and a poker game is a combination of skill and chance--chance in the hand and skill in the quality of betting.

Most games also have analogies to real life processes. This is by no means accidental, because the games were designed to mimic real life events of significance, and, therefore, that is the reason for their entertainment value. Chess was originally a war game. I suppose that "Monopoly" is a crude simulation of some of the economics of real estate. Also, there are fantasy aspects of game-like activities such as the dance or music drama that aren't intended to be realistic at all any more than a tune sounds realistically like bird calls or traffic, and they're a purely lyric and expressive element in games.

Educational games are combinations of the four elements--skill, chance, reality, and fantasy--and they tend to focus on reality. The purpose of educational games is two-fold--to motivate and to induce active understanding of information. To motivate most of our students, they must perceive some relevance between what they're learning and their future aspirations. If the game deals with the various aspects of the real world that are intrinsically interesting to them because of their

future aspirations, motivation will be enhanced just through the substantive content of the game and not only through the fun of playing the game itself. The other reason for having high reality content is the instructional objective of getting across a great many facts and ideas. The balance between skill and chance in games is a very important factor in design; and we purposefully distort the skill element slightly, that is, we tend to over-emphasize it. In the real world, as I am sure you are aware, hard effort, intelligence, and good will don't always win the game. We distort reality, somewhat, in our educational games and tend to make winning in the game more a function of effective decision-making than it might be in the real world.

This Calvinistic bias in our games is intentionally introduced to give people some feeling for the positive value of the things they are learning and the relevance of what they are learning to achieving their objectives. On the other hand, and this is a very healthy thing for under-achievers, it is necessary to humble the over-achievers in the classroom a little bit and give them some feeling that intelligence and hard work don't always win the game. This is done by introducing some element of chance so that the quality of decisions does not always control the world and what is going to happen.

These characteristics of games, the determinism and the chance element, are even mirrored in the tastes for different types of games by different type of populations. Our middle class which tends to be Calvinistic and has demonstrated the worth of hard work and good sense tends to like more deterministic games, while our disadvantaged populations who have some reason not to believe in the just nature of the world tend to prefer games with more of a pure chance element, such as numbers and dice. We try to introduce both these views to some extent in our games, but as I say we distort somewhat in the Calvinistic direction, suggesting that hard work and intelligence pay off perhaps a little more than they actually do.

The reality-fantasy balance is a much easier thing to decide because the fantasy element only has to be sufficient to involve the active participation of the players, and this is the role play element. We find that it is completely superfluous and, in fact, sometimes harmful to encourage role playing in our games because children and adults seem

to be such natural "hams" that if you just define a role for them, they will automatically fill it out, and if you just stress the role-playing they will tend to overdo it and go into long and timewasting speeches. So the fantasy element is taken care of by simple definition of the role that has to be played.

In the game design process, we follow a particular sequence. This sequence, incidentally, is also a sequence of problem solving or of systems analysis and isn't necessarily only a game design sequence. The first step is to define the overall objective whether it is instructional or experimental or analytic. We may use a game to demonstrate something, to teach, to train, to analyze, to explore alternatives, and so forth. If our objective is teaching, we should define as operationally as possible what behavior we want the student to be capable of after the game that he was not capable of before the game. The second step is to determine the scope of the game in terms of the simulated duration, geographic scope, and the issues that are to be exercised. In "Empire" we were concerned with the twenty-year period immediately preceding the American Revolution; we were concerned with the North Atlantic area; and we were concerned with the issue of mercantilism in the interactions between the economics of the trade of the area and the politics of that trade.

The next step is to identify the key actors in the situation. The actors may be individual decision makers, groups of people, nations, consumer groups, political groups, forces of nature. These actors are distinguished by their significance to the outcome of the situation being studied, and their relative autonomy from each other in their decision making.

The next step is to identify the actors' objectives in terms of their political, economic, military, cultural objectives or whatever seems to be relevant to the particular contest and their resources for achieving these objectives. The resources may be economic, political, and psychological. Another important resource is information, and different actors will have different degrees of information.

After this, one determines an interaction sequence--that is, the order in which information and quantities of goods, or any kind of material that's exchanged flow from independent actor to independent actor. This is best done with a simple flow chart with arrows showing the order of things from box to box. It will also show what events go on simultaneously in time, and what events follow other events.

The next step is to determine the decision rules or the criteria for action by the actors. In other words, after they get certain information from some other actor, and they perceive certain objectives to be threatened, on what kind of criteria do they base their decision. In computer simulations this can be done quantitatively. You can say, when variable X gets to a certain threshold value, it is to trigger off a certain resource allocation sub-routine, etc. We all use these decision rules ourselves. We say that if our savings bank account falls below a thousand dollars, we will put more money in it to bring it back to a thousand. That's an example of a decision rule. Or, if I don't get a raise within two years in this particular job, I'm going to change jobs. That's a decision rule.

After this, one identifies the constraints on the actions of the actors. Pervasive constraint may be an international relations game if all the players are Quakers, and no violence can be used to achieve the objectives. These are overall constraints on the activities of the actors.

Almost the last step now is to identify the win criteria. In a systems analysis the win criteria are just measures of effectiveness, or criteria for the effectiveness with which the actors achieve their particular objectives at a minimum commitment of their resources. In most educational games there is more than one winner and there are degrees of winning because the games, simulating reality as they do, have mixtures of competition and cooperation, and it is often possible for several people to win. In other words, a social optimum can be achieved through cooperative activities where everybody can win or many people can win by certain types of cooperation; or conversely most everybody can lose by unnecessarily conflictful behavior.

The final problem in design is to choose the form of presentation of the problem--whether it be a board game in which counters are manipulated because things can be neatly represented in two-dimensional format; whether it be a role-play game because this involves a great deal of negotiating interaction between many different roles; or whether it should be a combination of the two. If we're doing a problem analysis rather than an educational game, we may want to decide at this point whether we should do a "paper and pencil" analysis, whether we should do an operational game to test out alternatives, or whether we should do a computer simulation if we have a good enough quantitative understanding of the variables.

In all educational games we have a necessary trade-off or compromise to make between realism and simplication, between concentration and comprehensiveness, and between melodrama and analysis. Educational games, just like textbooks and lectures, are simplifications of reality. The amount of simplification necessary has to be very carefully controlled because one can simplify to the point where the game is easily playable but no longer a meaningful simulation of reality, or one can make a very sophisticated simulation of reality that simply isn't playable in the hour or two available in the classroom.

The typical mistake of the neophyte games designer is to try to cram everything into one game. It is usually much better to disaggregate the issue to be dealt with into several separate game situations. An analogy can be made to the classroom. If you have thirty players or students in a classroom, and each one plays a separate role, and there are thirty separate roles, and they each have to wait their turn, then each player has to wait twenty-nine turns for the next chance to make a decision. That would be very dull, so the thing to do in that case is to break up the game into, perhaps, five six-member teams, or to make several parallel game plays. The whole point of games for motivating students is to obtain their active involvement.